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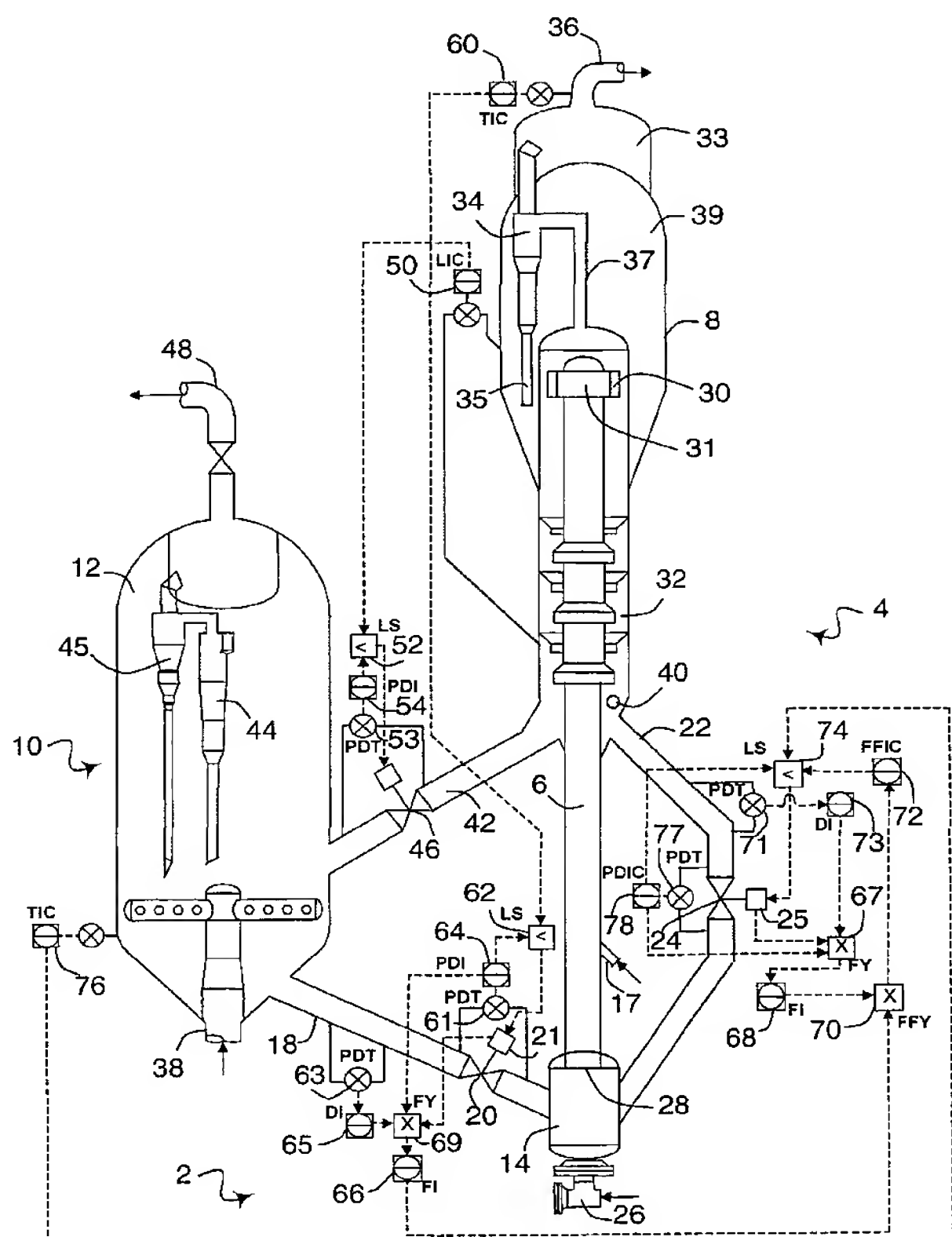
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FCC PROCESS AND APPARATUS WITH AUTOMATIC CATALYST RECYCLE CONTROL

(57) Abstract: An FCC process and apparatus that blends spent and regenerated catalyst before the contacts the feed in a reaction zone. The circulation rate of spent catalyst is automatically controlled based on a circulation rate of regenerated catalyst.



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**“FCC PROCESS AND APPARATUS WITH AUTOMATIC
CATALYST RECYCLE CONTROL”**

FIELD OF THE INVENTION

[0001] This invention relates to a fluidized catalytic cracking (FCC) process and apparatus in which spent catalyst particles are sent to a regenerator before being sent back to a reaction zone while other catalyst particles are recycled back to the cracking zone without regeneration. Specifically, this invention relates to controlling the circulation rate of unregenerated, spent catalyst recycled back to the reaction zone.

DESCRIPTION OF THE PRIOR ART

[0002] Catalytic cracking is accomplished by contacting hydrocarbons in a reaction zone with a catalyst composed of finely divided particulate material. As the cracking reaction proceeds, substantial amounts of coke are deposited on the catalyst. A high temperature regenerator within a regeneration zone operation burns coke from the catalyst. Coke-containing catalyst, referred to generally by those skilled in the art as spent catalyst, is continually removed from the reaction zone and replaced by essentially coke-free catalyst from the regeneration zone. Fluidization of the catalyst particles by various gaseous streams facilitates the transport of catalyst between the reaction zone and regeneration zone. Methods for cracking hydrocarbons in a fluidized stream of catalyst, transporting catalyst between reaction and regeneration zones, and combusting coke in the regenerator are well known by those skilled in the art of FCC processes. To this end, the art is replete with vessel configurations for contacting catalyst particles with feed and regeneration gas, respectively.

[0003] One such configuration is disclosed in US 5,451,313 B1 in which a portion of the spent catalyst is stripped and sent to the regeneration zone where it is regenerated and sent to a mixing vessel at the base of the riser and another portion of the spent catalyst is sent from the stripping vessel to the mixing vessel at the base of the riser without
5 undergoing regeneration. The cooler spent catalyst mixes with the hotter regenerated catalyst to produce a lower overall temperature of the catalyst contacting the feed. This configuration reduces the localized overheating of the feed or the severity of the feed heating caused by the large temperature differentials between the feed and the catalyst which both contribute to feed overcracking.

10 [0004] In FCC systems, spent catalyst is typically sent from the base of the stripping vessel to the regenerator through a spent catalyst conduit. Regenerated catalyst is passed from the regenerator vessel through a regenerated catalyst conduit to the base of the reaction zone. The circulation rate of the spent catalyst through the spent catalyst conduit is maintained by a spent catalyst control valve, and the circulation rate of the catalyst
15 through the regenerated catalyst conduit is maintained by a regenerated catalyst control valve. Spent catalyst that will not undergo regeneration is recycled either from the separator vessel or, specifically, the stripping vessel to the base of the riser by a recycled catalyst conduit. A recycled catalyst control valve regulates the recycled catalyst circulation rate. The respective catalyst circulation rate through the spent catalyst control
20 valve, the regenerated catalyst control valve and the recycled catalyst control valve is approximated using the density in the respective catalyst conduit, the differential pressure across the control valve and the position of the control valve relative to fully opened.

[0005] The spent catalyst control valve automatically controls the circulation rate of
25 spent catalyst from the separator vessel to the regenerator to maintain a constant catalyst

level in the separator. The regenerated catalyst control valve to maintain a constant temperature of the separator vessel automatically controls the circulation rate of hot regenerated catalyst from the regenerator to the riser. The controls that operate each of the spent catalyst and regenerated catalyst control valves also include a low differential pressure override. If the differential pressure across either slide valve drops to a very low or negative value, the override will close the control valve. This minimizes the possibility of reverse flow in the conduits, either air entering the separator vessel or feed entering the regenerator, which are hazardous situations.

[0006] No direct measured variable has been used to control the recycled catalyst circulation rate through the recycled catalyst control valve. Therefore, an automatic control is needed, so the operator does not have to adjust the spent catalyst circulation rate based on a change in the feed rate or the regenerated catalyst circulation rate.

[0007] US 2,743,998 B1, US 3,591,783 B1, US 3,964,876 B1, US 4,220,622 B1 and US 4,234,411 B1 all disclose FCC systems with automatic controls for regulating the FCC process. However, none of these references pertains to recycling spent catalyst to the reaction zone without undergoing regeneration or a means for controlling the circulation rate of such spent catalyst. Accordingly, it is an object of this invention to provide a means for automatically controlling the circulation rate of spent catalyst to the reaction zone without undergoing regeneration.

SUMMARY OF THE INVENTION

[0008] In one embodiment, the present invention relates to an apparatus for the fluidized catalytic cracking of hydrocarbons. The apparatus comprises a reaction zone in which blended catalyst is contacted with a hydrocarbon feed. A separator vessel receives effluent from the reaction zone and separates the effluent into a vapor product and spent

catalyst. A recycled catalyst conduit communicative with the separator vessel passes spent catalyst to the reaction zone. The recycled catalyst conduit includes a recycled catalyst control valve for regulating spent catalyst circulation. A regeneration zone removes carbon from the spent catalyst to provide regenerated catalyst. A spent catalyst conduit communicative between the separator vessel and the regeneration zone passes spent catalyst to the regeneration zone. A regenerated catalyst conduit communicative between the regeneration zone and the reaction zone passes regenerated catalyst from the regeneration zone to the reaction zone. The regenerated catalyst is blended with the spent catalyst in the reaction zone to provide the blended catalyst. A recycled catalyst controller sets a position of the recycled catalyst control valve dependent on whether a relationship between the circulation rate of spent catalyst through the recycled catalyst conduit and the circulation rate of regenerated catalyst through the regenerated catalyst conduit meets a preset condition.

BRIEF DESCRIPTION OF THE DRAWING

[0009] The FIGURE is an elevational schematic view showing an FCC unit in accordance with this invention.

DETAILED DESCRIPTION OF THE INVENTION

[0010] This invention is associated with an FCC process. The FIGURE shows a typical schematic arrangement of an FCC unit 2 arranged in accordance with this invention. The description of this invention in the context of the specific process arrangement shown is not meant to limit it to the details disclosed therein. The FCC unit 2 shown in the FIGURE consists of a reaction zone 4 comprising an elongate riser 6 and

a separator vessel 8, and a regeneration zone 10 comprising a regenerator 12. The arrangement circulates catalyst and contacts feed in the manner hereinafter described.

[0011] The catalyst that enters the riser 6 can include any of the well-known catalysts that are used in the art of fluidized catalytic cracking. These compositions include amorphous-clay type catalysts or high activity, crystalline alumina silica or zeolite containing catalysts.

[0012] FCC feedstocks, suitable for processing by the method of this invention, include conventional FCC feeds and higher boiling or residual feeds. The most common of the conventional feeds is a vacuum gas oil which is typically a hydrocarbon material having a boiling range of from 343° to 552°C (650° to 1025°F) and is prepared by vacuum fractionation of atmospheric residue.

[0013] Riser 6 is one type of conversion vessel that can be used in conjunction with this invention. The riser type conversion vessel comprises a conduit for the pneumatic conveyance of the blended catalyst mixture and the feed stream. The base of the riser 6 may include a blending vessel 14.

[0014] Feed is introduced into the riser 6 somewhere between inlet 28 and substantially upstream from an outlet 30. The feed enters by nozzle 17 in the FIGURE, usually in a lower portion of the riser 6. Before contacting the catalyst, the feed will ordinarily have a temperature in a range of from 149° to 316°C (300° to 600°F).

Additional amounts of feed may be added downstream of the initial feed point.

[0015] A regenerated catalyst conduit 18 passes regenerated catalyst from the regenerator 12 into the blending vessel 14 at a circulation rate regulated by a control valve such as slide valve 20. A recycled catalyst conduit 22 passes catalyst from separator vessel 8 at a circulation rate regulated by a control valve such as slide valve 24 into blending vessel 14. Fluidizing gas passed into blending vessel 14 by a nozzle 26

contacts the catalyst and maintains the catalyst in a fluidized state to mix the recycled catalyst and regenerated catalyst.

[0016] The regenerated catalyst will have a substantially higher temperature than the recycled catalyst. Regenerated catalyst from the regenerated catalyst conduit 18 will usually have a temperature in a range from 593° to 760°C (1100° to 1400°F) and, more typically, in a range of from 649° to 760°C (1200° to 1400°F). The temperature of the recycled catalyst will usually be in a range of from 482° to 621°C (900° to 1150°F). The relative proportions of the recycled catalyst and regenerated catalyst will determine the temperature of the blended catalyst mixture that contacts the feed. The blended catalyst mixture will usually range from 538° to 760°C (1000° to 1400°F) and, more preferably is in a range of from 566° to 677°C (1050° to 1250°F). Ordinarily, the ratio of recycled catalyst to regenerated catalyst entering the blending zone will be in a broad range of from 0.1 to 5 and more typically in a range of from 0.5 to 1.0. Once the blended catalyst mixture contacts the feed, the blended catalyst mixture cracks the feed to smaller molecules.

[0017] The separator vessel 8 typically includes a stripping vessel 32. The blended catalyst mixture and reacted feed vapors are then discharged from the end of riser 6 through an outlet 30 into the stripping vessel 32 of the separator vessel 8. A swirl arm arrangement 31, provided at the end of riser 6 imparts a tangential velocity to the exiting catalyst and converted feed mixture to separate a product vapor stream from a collection of catalyst particles covered with substantial quantities of coke and generally referred to as "spent catalyst".

[0018] Direct conduit 37 passes a product vapor stream to a cyclone separator 34 in a primary chamber 39 of the separator vessel 8. The cyclone separator 34 further removes catalyst particles from the product vapor stream to reduce particle concentrations to very

low levels. Product vapors comprising cracked hydrocarbons and some catalyst exit the top of separator vessel 8 through conduit 36 via plenum chamber 33. Catalyst separated by cyclone separator 34 returns to the separator vessel 8 through dipleg conduits 35 into a dense catalyst bed (not shown).

5 **[0019]** Catalyst drops through the stripping vessel 32 that removes adsorbed hydrocarbons from the surface of the catalyst by counter-current contact with steam. Steam enters the stripping vessel 32 through at least one line 40.

10 **[0020]** Spent catalyst stripped of hydrocarbon vapor leave the bottom of stripping vessel 32 through a spent catalyst conduit 42 at a rate regulated by a control valve such as slide valve 46. Spent catalyst for recycled to the base of the riser 6 may be withdrawn from the separator vessel 8 or even riser 6 after the spent catalyst has undergone a sufficient reduction in temperature. Spent catalyst is most typically withdrawn downstream of the riser 6 and, more typically, from the stripping vessel 32. The FIGURE depicts the withdrawal of spent catalyst from a lower portion of the stripping vessel 32.

15 A recycled catalyst conduit 22 transfers one portion of the spent catalyst exiting the separator vessel 8 back to the blending vessel 14 as recycled catalyst. A spent catalyst conduit 42 transfers another portion of the spent catalyst to the regenerator 12 for the removal of coke in the regeneration zone 10.

20 **[0021]** On the regeneration side of the process, spent catalyst transferred to the regenerator 12 via spent catalyst conduit 42 undergoes the typical combustion of coke from the surface of the catalyst particles by contact with an oxygen-containing gas. The oxygen-containing gas enters the bottom of the regenerator 12 via an inlet 38 and passes through a dense fluidizing bed of catalyst (not shown). Flue gas consisting primarily of CO or CO₂ passes upward from the dense bed into a dilute phase of regenerator 12. A
25 separator, such as the cyclones 44 and 45, remove entrained catalyst particles from the

rising flue gas before the flue gas exits the vessel through an outlet 48. Combustion of coke from the catalyst particles raises the temperatures of the catalyst to those previously described. The regenerated catalyst is transferred by regenerated catalyst conduit 18 to the base of the riser 6 in reaction zone 4.

5 **[0022]** The circulation rate of spent catalyst from the separator vessel 8 to the regenerator 12 through the spent catalyst conduit 42 is regulated by the slide valve 46, and the circulation rate of regenerated catalyst from the regenerator 12 to the base of the riser 6 is controlled by the slide valve 20. The circulation rate of spent catalyst from the stripping vessel 32 of the separator vessel 8 through the recycled catalyst conduit 22 is
10 regulated by the slide valve 24. Slide valves 20, 24 and 46 have a setting that corresponds to a position of the slide valve relative to a fully opened valve.

[0023] The spent catalyst slide valve 46 is automatically controlled. A level indicating controller (LIC) 50 receives a signal of the levels of the catalyst in the primary chamber 39 and in the stripping vessel 32 of the separator vessel 8. The LIC 50
15 signals to a low signal selector (LSS) 52 a setting for the spent catalyst slide valve 46 relative to fully open to bring the respective levels in the separator vessel 8 and in the stripping vessel 32 to the desired preset levels. A pressure differential transmitter (PDT) 53 senses and determines a differential pressure across spent catalyst slide valve 46 and signals a pressure differential to pressure differential indicating controller (PDIC) 54.

20 The PDIC 54 signals a setting for the spent catalyst slide valve to the LSS 52. If the differential pressure across the spent catalyst slide valve 46 is greater than an override setpoint, typically 0.14 kg/cm^2 (2 lbs/in^2), the LSS 52 will select and signal the slide valve 46 to adjust to the setting from the LIC 50. Nevertheless, the LSS 52 will send the lowest setting to the spent catalyst slide valve 46.

[0024] The regenerated catalyst slide valve 20 is also automatically controlled. A pressure differential transmitter (PDT) 61 senses and determines a pressure differential across the regenerated catalyst slide valve 20. The PDT signals the pressure differential to the pressure differential indicating controller 64 (PDIC) which signals a setting to a low signal selector (LSS) 62. A temperature indicating controller (TIC) 60 receives a temperature signal of the effluent gas from the separator vessel 8 in conduit 36, and signals a setting to the LSS 62 designed to open or close the slide valve 20 to effect the preset temperature desired in the separator vessel 8. If the differential pressure across the slide valve 20 is greater than an override setpoint, typically 0.14 kg/cm^2 (2 lbs/in^2), the LSS 62 will select and signal the slide valve 20 to adjust to the setting signaled from the TIC 60. Again, the LSS 62 will signal the lowest setting to the regenerated catalyst slide valve 20.

[0025] The regenerated catalyst conduit 18 and the recycled catalyst conduit 22 include instrumentation to determine the circulation rate through the respective slide valves 20 and 24. It should be understood that the determinations of the circulation rates are not precise, but they are sufficient for the purpose of controlling operation of the FCC unit 2. The circulation rate is determined by a formulation of the density of the recycled catalyst stream, the position of the respective slide valve relative to fully open as indicated by the setting thereof and the differential pressure across the respective slide valve.

[0026] The instrumentation for determining the circulation rate of regenerated catalyst through the regenerated catalyst slide valve 20 includes the following. Density in the regenerated catalyst conduit 18 is determined by density indicator (DI) 65 which factors readings from a pressure differential transmitter (PDT) 63 with connections placed at different heights along the regenerated catalyst conduit 18 upstream of the

regenerated catalyst slide valve 20. The pressure differential across the slide valve 20 is determined by a signal from a pressure differential transmitter (PDT) 61 with connections placed upstream and downstream of the slide valve 20. The PDT 61 signals the pressure differential to a pressure differential indicating controller (PDIC) 64. The DI 65 signals a density value, the PDIC 64 signals a pressure differential value and the actuator 21 signals a value for the setting of the slide valve 20 all to a flow computer (FY) 69. The FY 69 determines the flow rate of the regenerated catalyst based on the density, pressure differential and valve setting signals received and transmits the regenerated catalyst circulation rate to the a flow indicator (FI) 66. The FI 66 signals the determined regenerated catalyst circulation rate to a flow fraction computer (FFY) 70.

[0027] The instrumentation for determining the circulation rate of spent catalyst through the recycled catalyst slide valve 24 includes the following. Density in the recycled catalyst conduit 22 is determined by density indicator (DI) 73 which factors readings from a pressure differential transmitter (PDT) 71 with connections placed at different heights along the recycled catalyst conduit 22 upstream of the recycled catalyst slide valve 24. The pressure differential across the slide valve 24 is determined by a signal from a pressure differential transmitter (PDT) 77 with connections placed upstream and downstream of the slide valve 24. The PDT 77 signals the pressure differential to a pressure differential indicating controller (PDIC) 78. The DI 73 signals a density value, the PDIC 78 signals a pressure differential value and the actuator 25 signals a value for the setting of the slide valve 24 all to a flow computer (FY) 67. The FY 67 determines the flow rate of the recycled catalyst based on the density, pressure differential and valve setting signals received and transmits the recycled catalyst circulation rate to the a flow indicator (FI) 68. The FI 68 signals the determined recycled catalyst circulation rate to the FFY 70.

[0028] The spent catalyst conduit 42 may include similar instrumentation for determination of the spent catalyst circulation rate but it is not necessary for purposes of the invention.

[0029] The FFY 70 determines a process variable based on a relationship between the circulation rate of spent catalyst through the recycled catalyst conduit 22 and the circulation rate of regenerated catalyst through the regenerated catalyst conduit 18. It is preferred that this relationship be a ratio of a sum of the regenerated catalyst circulation rate and the spent catalyst circulation rate to the regenerated catalyst circulation rate:

$$\text{Process Variable} = \frac{\text{Regenerated Catalyst Circulation Rate} + \text{Recycled Catalyst Circulation Rate}}{\text{Regenerated Catalyst Circulation Rate}}$$

[0030] The FFY 70 determines the process variable and signals an outputted process variable to a flow fraction indicating controller (FFIC) 72 which compares the process variable to a preset value. If there is a difference between the actual process variable and the preset value, then the FFIC 72 signals to a low signal selector (LSS) 74 a setting to which the slide valve 24 should be positioned to return the process variable to the preset value. The LSS 74 also receives output settings for the slide valve 24 from a temperature indicating controller (TIC) 76 that monitors the temperature of the regeneration zone 10 and the pressure differential indicating controller (PDIC) 78 that monitors the differential pressure across the slide valve 24. The LSS 74 selects the lowest setting of the position of the slide valve relative to fully open and will signal this lowest setting to the actuator 25 for slide valve 24. Because the TIC 76 and the PDIC 78 are overrides, they will typically only signal settings of 100% open to the LSS 74. Hence, the setting signaled by the FFIC 72 will typically control the setting of the slide valve 24. However, if the regenerator temperature exceeds the predetermined override setpoint, typically 732°C

(1350°F) or the differential pressure across the slide valve 24 is less than or equal to the override setpoint, typically 0.14 kg/cm² (2 lbs/in²), the respective indicating controller will signal a setting of the position of the slide valve 24 which is less than 100% fully open. Again, this LSS 74 will select the lowest setting and output that lowest setting to the actuator 25 for slide valve 24.

[0031] The slide valve 24 may be controlled automatically based on a relationship between the circulation rate of the recycled catalyst and the regenerated catalyst. The LSS 74, and the TIC 76 and PDIC 78 overrides enhance the control of the slide valve 24 but are not necessary features.

CLAIMS:

1. An apparatus for the conversion of hydrocarbons, the apparatus comprising:
a reaction zone in which blended catalyst is contacted with a hydrocarbon feed;
a separator vessel for receiving effluent from said reaction zone and separating
5 said effluent into a vapor product and spent catalyst;
a recycled catalyst conduit communicative with said separator vessel for passing
spent catalyst to said reaction zone;
a regeneration zone for removing carbon from said spent catalyst to provide
regenerated catalyst;
10 a spent catalyst conduit communicative between said separator vessel and said
regeneration zone for passing spent catalyst to said regeneration zone;
a regenerated catalyst conduit communicative between said regeneration zone
and said reaction zone for passing regenerated catalyst from said regeneration
zone to said reaction zone, said regenerated catalyst conduit providing
15 regenerated catalyst for blending with said spent catalyst to provide said
blended catalyst;
further characterized in that a recycle catalyst controller for regulating spent
catalyst circulation through said recycle catalyst conduit sets a position of a
recycle catalyst control valve dependent on whether a relationship between
20 the circulation rate of spent catalyst through said recycle catalyst conduit and
the circulation rate of regenerated catalyst through said regenerated catalyst
conduit meets a preset condition.

2. The apparatus of claim 1 wherein said regenerated catalyst conduit includes a regenerated catalyst control valve for regulating regenerated catalyst circulation to said reaction zone.

3. The apparatus of claim 1 wherein said reaction zone comprises a riser.

5 4. The apparatus of claim 3 wherein a base of said riser comprises a blending vessel in which recycled catalyst and regenerated catalyst are blended.

5. The apparatus of claim 1 wherein said separator vessel includes a stripping vessel for stripping hydrocarbons from said spent catalyst and said spent catalyst conduit and said recycle catalyst conduit are communicative with said stripping vessel.

10 6. The apparatus of claim 1 wherein the relationship between the circulation rate of spent catalyst through said recycle catalyst conduit and the circulation rate of regenerated catalyst through said regenerated catalyst conduit is the ratio of a sum of the circulation rate of spent catalyst through said recycle catalyst conduit and the circulation rate of regenerated catalyst through said regenerated catalyst conduit to the circulation rate of regenerated catalyst through said regenerated catalyst conduit.

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7. The apparatus of claim 1 wherein said recycled catalyst conduit includes instrumentation for determining the circulation rate of spent catalyst through said recycled catalyst conduit and said regenerated catalyst conduit includes instrumentation for determining the circulation rate of regenerated catalyst through said regenerated catalyst conduit.

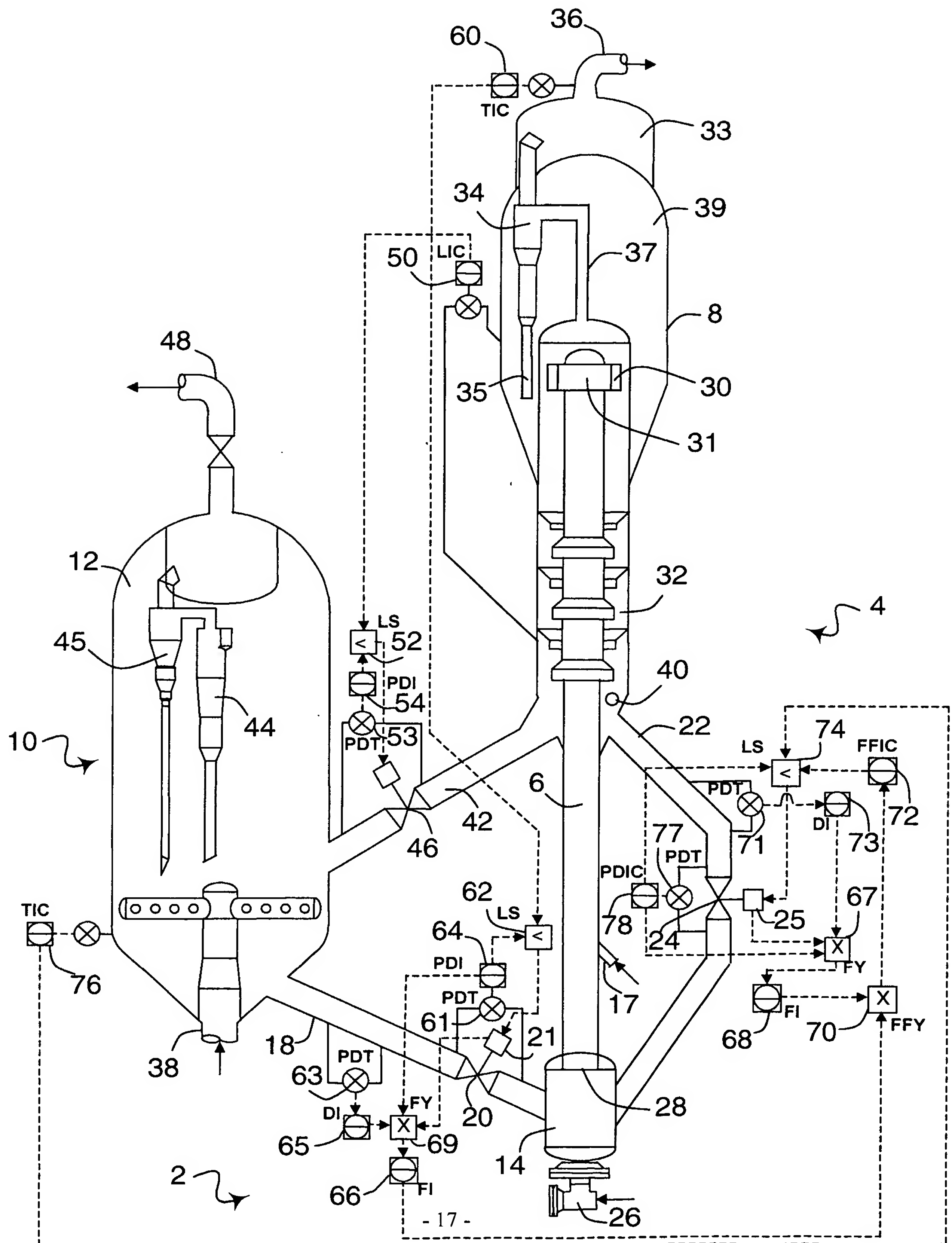
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8. The apparatus of claim 1 wherein said controller signals a setting to a low signal selector, said low signal selector also being receptive to signals of a setting from at least one other controller and said low signal selector signals the lowest setting to the recycle catalyst control valve.

9. The apparatus of claim 8 wherein a pressure differential indicating controller signals a setting signal to the low signal selector based on a pressure differential determined across said recycle catalyst control valve.

10. The apparatus of claim 8 wherein a temperature indicating controller signals a
5 setting signal to the low signal selector based on a temperature of said regeneration zone.

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INTERNATIONAL SEARCH REPORT

International Application No

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C10G11/18 B01J8/18 B01J8/24 B01J8/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10G B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 451 313 A (WEGERER DAVID A ET AL) 19 September 1995 (1995-09-19) cited in the application claim 1; figure 1 column 4, line 29-36 column 6, line 17-20 column 7, line 50-53 column 8, line 64 -column 9, line 4 * column 9, lines 19-25 and 49-63 * * column 11, lines 29-36 and 50-55 * --- -/--	1-10



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

° Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/09949

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2 965 454 A (HARPER KENNETH A) 20 December 1960 (1960-12-20) claim 1; figure 1 column 3, line 18-37 column 2, line 32-41 column 4, line 53-71 * column 5, lines 34-37 and 59-65 * column 6, line 12-33 ---	1-10
X	US 6 143 253 A (RADCLIFFE WILLIAM H ET AL) 7 November 2000 (2000-11-07) claim 1; figure 1 column 5, line 56 -column 6, line 3 column 6, line 34-51 column 7, line 32-39 ---	1-10
X	US 6 183 699 B1 (LOMAS DAVID A) 6 February 2001 (2001-02-06) claim 1; figure 1 column 3, line 25-30 column 6, line 14-19 column 7, line 15-19 column 8, line 2-9 * column 9, lines 1-8 and 49-55 * column 11, line 39-45 ---	1-10
A	US 6 010 620 A (SATTAR AZIZ A ET AL) 4 January 2000 (2000-01-04) claim 1; figure 1 * column 6, lines 7-9 and 22-51 * -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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